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Sixth National Conference on Standards

". . . . Cooperation with other governmental agencies and with private organizations in the establishment of standard practices . . . . . "

Public Law 619, 81st Congress

The above quotation describes the role of the National Bureau of Standards in industrial standardization. It also provides the authority under which the Bureau joins with the American Standards Association in sponsoring the Sixth National Conference of Standards on October 24 to 26, 1955. Based on the theme "government-industry cooperation in standardization," the Conference will bring together both industrial and Government leaders for a three-day program designed to promote closer cooperation in the development and use of standards.

As the largest single purchaser in the world, the Federal Government must buy on an impartial and competitive basis. Both for this reason and for reasons of economy, specifications must be established in order that the bid system may be used. This assures all suppliers of an opportunity to sell to the Government strictly on the basis of merit and price. Goods of uniform and serviceable quality are thus acquired, and difficulties in cataloguing, stocking, and handling are minimized. Good management dictates that government standards be designed for economical production and conform where possible to existing industry standards.

The Conference will feature subjects ranging from the legal implications of standardization to the coordination of defense and industry requirements for manufactured products. Because of the size and scope of the military procurement program, one session will be devoted to government-industry standards at the Secretary of Defense level; a second session will deal with such standards at the level of the Army, Navy, and Air Force. The relationship of industry standards for civilian goods to those of the Government will be considered at a session sponsored by the General Services Administration. Government and industry have a common interest in the promotion of international trade; hence, the concluding session of the Conference quite appropriately will be devoted to cooperation in international standardization.

Dr. A. V. Astin, Director of the Bureau, will welcome the Conference to Washington at the opening ses-

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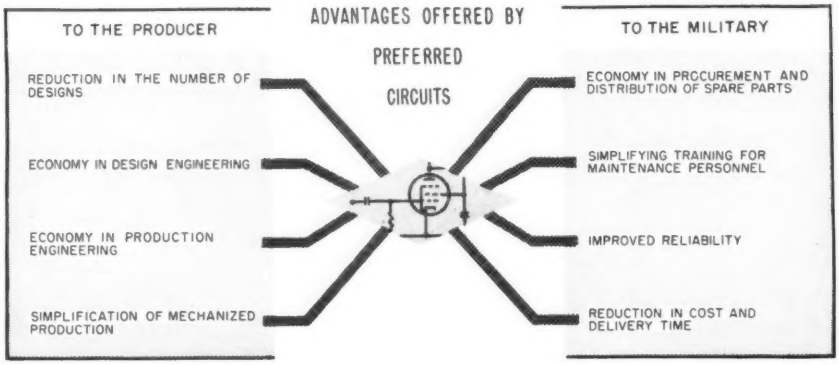
sion, which also constitutes the 37th Annual Meeting of the American Standards Association. A tour of the Bureau has been arranged for the afternoon of October 24, and will be followed by a tea on the Bureau grounds to afford an opportunity for Conference members to meet the senior NBS staff. As with other technical conferences in Washington, members have been invited to visit the Bureau at their convenience to discuss technical problems of mutual interest.

The Bureau welcomes the opportunity of cosponsoring the Conference because of its long and productive cooperation with the American Standards Association. A number of standards are currently being developed by ASA procedure under the sponsorship of the Bureau, and 248 memberships on technical committees of the ASA are held by Bureau staff members. Back of the Bureau's contributions to standardizing activities is its program of research and development in methods and standards for physical measurement. This program is continually expanding the frontiers of science in an effort to keep pace with industrial demands for new and improved standards.

NBS-BuAer Preferred Circuits Program

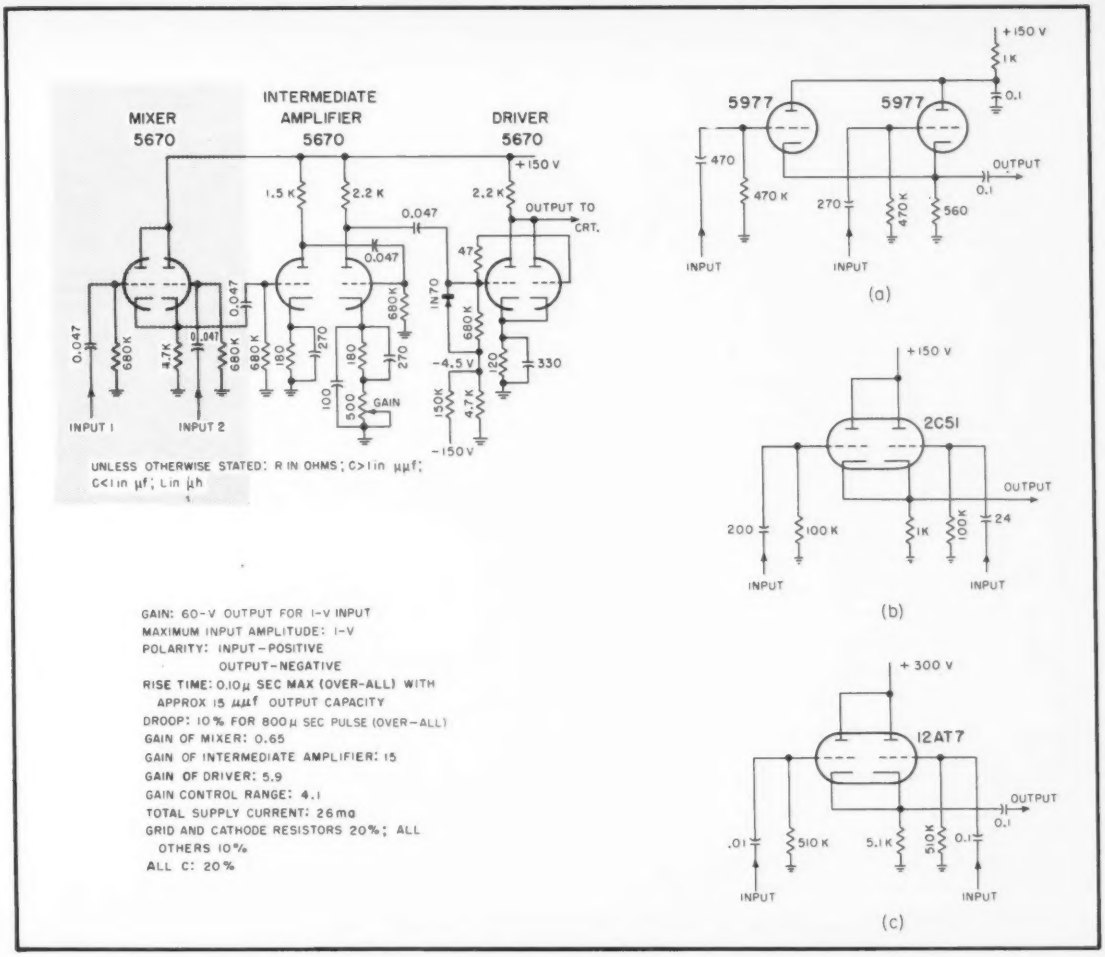


THE BUREAU has found that it is feasible to standardize many of the electronic circuits used in Navy aeronautical equipment. A standardization program, undertaken for the Navy Bureau of Aeronautics, is seeking to determine those well-known circuit configurations that are common to a wide variety of electronic devices but which now differ unnecessarily in detail. Known as the NBS–BuAer preferred circuits program, this continuing investigation may result in important economies in critical engineering man-hours, in lead time, and by accelerating production. It also should provide the military services with means for: (1) simplifying maintenance training; (2) designing simple "throwaway" units; (3) achieving improved operational reliability; and (4) establishing design standard levels. These objectives can be achieved without requiring a rigid compliance to the preferred circuits; [1] these circuits are intended as a design guide only. The study is being carried out by J. H. Muncy and associates of the NBS engineering electronics laboratories. The Bureau is cooperating with industrial groups engaged in similar programs through exchange of information.

The over-all circuit of any aeronautical electronic equipment is necessarily extremely complex, consisting of hundreds or thousands of individual "components" (resistors, capacitors, inductors, vacuum tubes) connected by a maze of wires. However, like any other complex mechanism such an over-all circuit does not represent a single entity designed as a whole for its particular function.

Rather, it is a composite of many individual smaller circuits, most of which are known and used in different combinations in other equipment having other functions. For example, most aeronautical electronic equipment includes rectifier circuits, and many include amplifier circuits, timing circuits, and others. Some circuits in a complete piece of equipment are unique and especially designed for that particular equipment, but the great majority of circuits in any device are of widely used types. Such widely used subcircuits are the essential building blocks of the over-all design. They are recognized as such in the "block diagram" language of electronic circuitry, in which the over-all circuit is represented in elementary form by a number of labeled rectangles, each corresponding to a subcircuit of known characteristics.

Although many electronic building blocks have become widely accepted for their general function and circuit arrangement, no attempt has been made to standardize their exact circuit configurations or the resistance or capacitance values of their components.



GAIN: 60-V OUTPUT FOR 1-V INPUT
MAXIMUM INPUT AMPLITUDE: 1-V
POLARITY: INPUT—POSITIVE
OUTPUT—NEGATIVE
RISE TIME: 0.10μ SEC MAX (OVER-ALL) WITH APPROX 15 μμf OUTPUT CAPACITY
DROOP: 10% FOR 800μ SEC PULSE (OVER-ALL)
GAIN OF MIXER: 0.65
GAIN OF INTERMEDIATE AMPLIFIER: 15
GAIN OF DRIVER: 5.9
GAIN CONTROL RANGE: 4.1
TOTAL SUPPLY CURRENT: 26 ma
GRID AND CATHODE RESISTORS 20%; ALL OTHERS 10%
ALL C: 20%

These representative examples of video mixers examined in preferred circuits program combine pulse information according to each specialized application. (a) Common-cathode mixer that combines pulses representing range markers and heading markers; (b) common-cathode mixer combining two positive polarity range strobe triggers; (c) combines 9 v positive polarity range markers with 2 to 10 v positive IFF signals. Preferred circuit that meets the requirements of these applications is (shaded) in the first or mixer stage of the circuit shown at upper left. This is a typical preferred circuit—a video chain for a radar system—developed for the Navy Bureau of Aeronautics. It mixes radar video signal with marker pulses and then amplifies combined signals to a level sufficient to intensity-modulate the cathode-ray indicator. Not intended for a specific application, this circuit will serve as a convenient guide in planning the video section of a radar set. Circuit includes principles that lead to manufacturing ease and insure highly reliable operation. Component types and values were selected to make circuit suitable for either mechanized or conventional production. In developing this circuit, a large number of video circuits were examined. This investigation showed that the engineer had had considerable latitude in choosing tube types, component values, and circuitry in designing video chains. Circuits examined were divided into individual stages to tabulate the data of stages performing the same function. This procedure led to restrictions in choosing operating voltages, tube types, and circuit parameters. The restrictions in turn formed basis for design of this preferred video chain circuit.

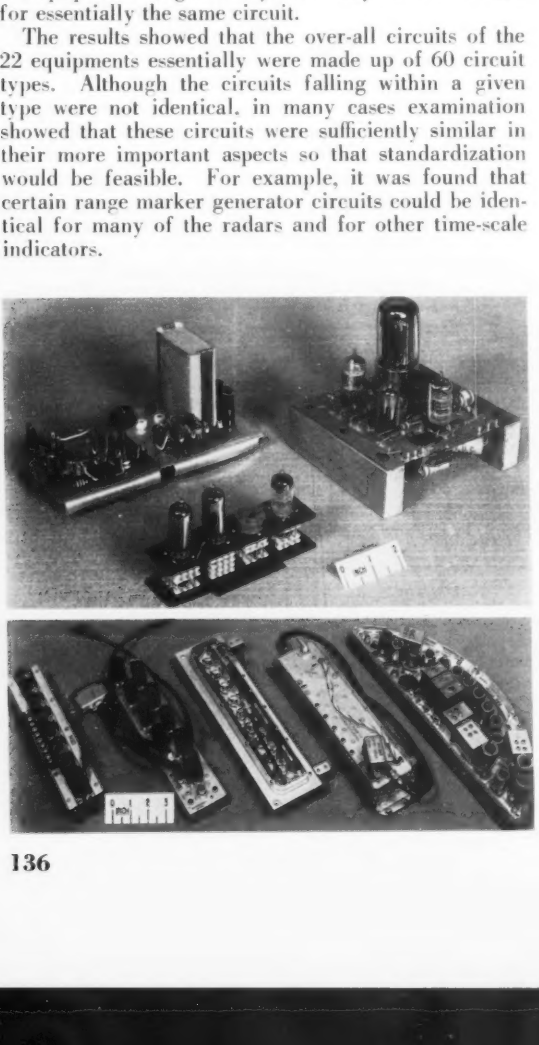
Engineers recognize that one of the great advantages of electronic techniques is the flexibility of the circuits, both during design and production, since an electronic assembly consists of many parts that may be rather easily replaced by others. Electronic engineers are naturally reluctant to surrender this flexibility except for great compensating advantages. Nevertheless, preliminary consideration by the Bureau of Aeronautics and a feasibility study by NBS showed that the standardization of circuits used in aeronautical electronic equipment should result in worthwhile advantages to both the military user and the industrial producer.

To the military services such standardization means lower purchase prices, shorter delivery time, greater operating reliability, fewer spare parts at field installations, and simpler maintenance procedures. For the producers, there is the prospect of economies in design and production engineering. Junior engineers, usually assigned the routine work of designing or selecting these well-known circuits, will have their work facilitated, and this in turn will reduce the supervisory burden of senior engineers. Production will benefit from fewer designs and reduced inventories.

Feasibility Study

The initial feasibility study, undertaken in 1953, consisted of a detailed examination of 22 carefully selected items of aeronautical electronic equipment. These included several different radar sets, an indicator assembly, radio equipment, and others. Sources of information included instruction manuals, specifications, and the experience and advice of equipment engineers and maintenance personnel. The over-all circuits were divided into functional subcircuits and then subjected to systematic analysis of the detailed circuit differences and of design parameters. Considerable attention was given to establishing a common terminology, as different equipment designers may use widely different names for essentially the same circuit.

The results showed that the over-all circuits of the 22 equipments essentially were made up of 60 circuit types. Although the circuits falling within a given type were not identical, in many cases examination showed that these circuits were sufficiently similar in their more important aspects so that standardization would be feasible. For example, it was found that certain range marker generator circuits could be identical for many of the radars and for other time-scale indicators.



Top: **Preferred circuits are readily adaptable to such different construction methods as mechanized production, printed circuitry, or laboratory breadboard techniques. Three different preferred circuits built by three different fabrication techniques are shown.** ***Bottom:*** **Five IF strips produced for Navy aeronautical equipment illustrate wide variation in size, shape, and circuitry. All perform the same electrical functions. One aim of the NBS-BuAer preferred circuits program is the reduction in the number of circuit designs for such equipment, thus reducing engineering man-hours and production lead time, simplifying maintenance, and improving operational reliability.**

In expressing the extent to which a given over-all equipment circuit is standardizable, it has become the practice to use the ratio of the number of vacuum tube cathodes in standardizable portions of the circuit to the number of cathodes in the over-all circuit. Cathodes are counted instead of entire vacuum tubes to avoid ambiguity resulting from such items as double triodes. On this basis, the feasibility study of the 22 pieces of equipment showed that 50 to 70 percent of the cathodes were standardizable. The remaining cathodes were in circuits too specialized to hold any reasonable prospect of standardization.

The most promising field of standardization was in the power supply circuits, which were considered to be standardizable in all of the equipments. It was also immediately evident that the first step should be the reduction of the unreasonably large number of power supply voltages. For example, it was found that the voltages used in 20 equipments showed 20 different nominal values which appeared readily reducible to four.

As a result of the favorable outcome of the feasibility study, work was immediately started on the preferred circuits program. Priority has been given to the most widely used and readily standardizable items. The work on any given circuit has required both theoretical and experimental studies of the known versions, so that a "least-common-denominator" circuit can be established. The preferred circuit is usually chosen from one of the existing designs, with required variations allowed by prescribed component value changes. As a result, the circuit is capable of equaling the performance while avoiding the faults of a large number of "original" versions. In no case were new circuits created.

The Bureau's preferred circuits are not offered as definitive solutions to the electronic design engineer's problems. However, the circuits so far published appear to be as good as those in common use and to be capable of definitely stated performance. Their use remains optional although encouraged for Navy aeronautical equipment.

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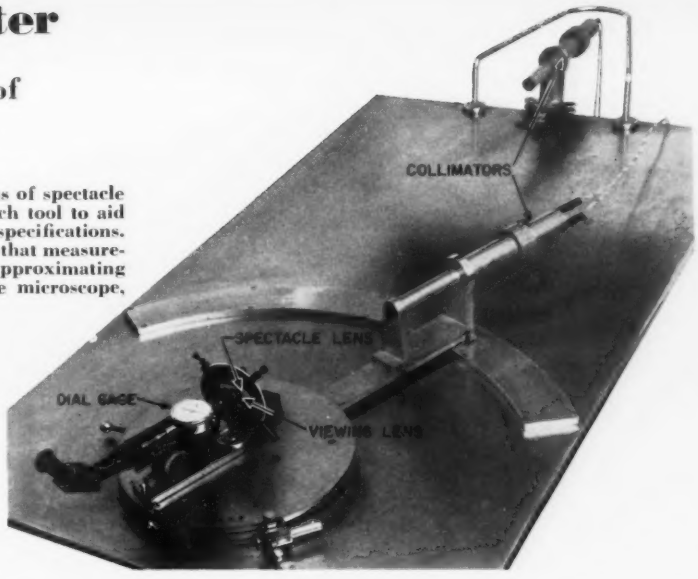
[1] *For further technical information, see* Preferred Circuits Manual, Navy Aeronautical Electronic Equipment, *NAVAER 16-1-519, published jointly by NBS and Navy Bureau of Aeronautics (in press) Government Printing Office, Washington 25, D. C. Communications concerning the NBS–BuAer preferred circuits program should be addressed to the Office of Technical Information, National Bureau of Standards, Washington 25, D. C.*

Spectacle Tester

Precise Evaluation of Spectacle Lenses



Instrument developed to test marginal areas of spectacle lenses. Apparatus is designed as a research tool to aid preparation of standard spectacle lens specifications. Viewing system simulates the rolling eye so that measurements are made under conditions closely approximating use. Viewing lens, attached to a movable microscope, is mounted behind the spectacle lens and forms image of test patterns that are in collimator. Viewing lens, microscope, and collimator are mounted on common pivot so they may rotate through an angle of 70° and be locked into place every 5°. Second collimator at top provides an infinitely distant target object which serves to determine entire system's optical axis. Dial gage registers microscope movement necessary to focus on image. This movement is interpreted in diopters giving the lens power at the point tested.

WITH the aid of a recently developed instrument, it is now possible to measure both central and marginal powers of a spectacle lens with accuracy. Known as the Spectacle Lens Tester, this instrument was designed by F. E. Washer in connection with an eyeglass lens study [1] that was conducted for the Veterans Administration. In operation the device simulates the refractive effect of the various parts of a particular lens upon the human eye. Although the Spectacle Tester is basically a research tool, its essential principles have been utilized to design marginal-power attachments [2] for the standard vertex-power instrument used by practicing opticians.

The earliest spectacle lenses had spherical surfaces only. However, when the existence of astigmatism was established, it was found that combining spherical and cylindrical surfaces improved vision, particularly in the axial region. Thus lens prescriptions specify a correction in terms of both spherical and cylindrical power measured in diopters. The layman refers to this power as the "strength" of his glasses.

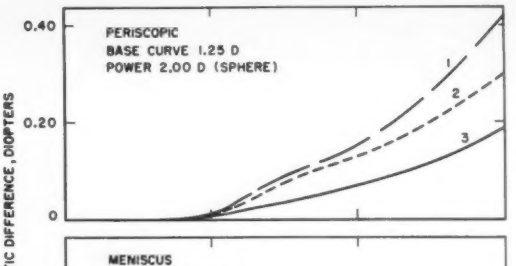
Achieving simultaneous accurate correction at all points on a lens is complex. Where only spherical power is involved, it is possible to determine the proper curvature of front and rear surfaces to yield zero marginal astigmatism for a specified object distance over a definite range. But for lenses having both spherical and cylindrical power, simultaneous marginal and axial correction is more difficult. An almost infinite number of lens shapes is possible. However, in practice a selected series of base curves has been found adequate for visual correction.

Each year the Veterans Administration purchases large quantities of spectacle lenses. To insure that the lenses provide as excellent vision correction as practicable, the VA requested the Bureau to develop practical specifications. They were to cover actual performance of both center and edge and the degree of marginal variation that might reasonably be allowed.

While spectacle lens accuracy can be determined rather easily at the optical center, the determination is much more difficult at other points. Probable marginal performance can be predicted by theory; but in actual practice slight variations in the surfaces of otherwise identical lenses can significantly vary their performance. Thus, to obtain data on allowable tolerances, it was necessary to design an instrument that would measure the actual performance of available lenses from various makers.

Ultimately the Spectacle Tester was developed for this purpose. It consists essentially of a short-focal-length lens that represents the eye's optical system, a horizontal microscope, and two collimators. The short-focal-length lens is placed a short distance from the eyepiece of the microscope. This part of the assembly is mounted on an instrument table in such a way that it can rotate through an arc of 70°. The spectacle lens to be tested is fixed in front of the microscope. On the other side of the spectacle lens, a movable collimator in line with the microscope swings about the same axis. The collimator contains test patterns representing objects viewed by the eye. A second collimator, fixed at the table's end, provides an infinitely distant object that serves to determine the optical axis of the entire system. When the viewing device is rotated from its center position, it receives images formed by parts of the spectacle lens that are correspondingly distant from the optical center.

The viewing device can be locked into position every 5°. In each position a dial gage on the microscope registers the movement required to focus on the test pattern. This movement can be interpreted to give the



Variation of astigmatism with angular separation from axis for two lenses having same axial powers but different surface curvature. Curves marked "1" give value for infinite object distance; those marked "2" for 0.50 meter; and those marked "3" for an object distance of 0.25 meter.

spectacle lens strength at the corresponding viewing angle.

Approximately 300 lenses from various sources have been tested with this apparatus. Although the degree of compliance with specifications did not vary significantly among the suppliers, it was sometimes found that lenses having identical power at the optical center varied by as much as 0.50 diopter in the marginal areas. And this variation itself is subject to change as the object distance increases from 0.25 meter to infinity.

The Spectacle Tester is well adapted for detailed study of all the visual properties of spectacle lenses, but it would be unnecessarily elaborate for routine testing of marginal powers. The Bureau has therefore designed attachments that permit marginal-power measurements on the standard vertex-power measuring instrument. The latter device is generally a small portable assembly that provides for clamping the spectacle lens between a collimator and a telescope mounted on a fixed axis. Such an instrument when unmodified can measure power at the optical center of a lens only.

The NBS attachments include a small hemispherical seating surface with a center opening and a clamping device to hold the lens under test against the hemisphere. The radius of the seating surface is 27 mm. the value customarily accepted as the axial distance separating the back surface of the spectacle lens and the eye's center of rotation.

For measuring marginal power at, for example, an angle of 30° from the axis of the lens, a dot is marked on the hemispherical surface to locate a point 30° from the axis. The optical center of the lens under test is then pressed against this dot, so that a point 30° from the center of the lens is now opposite the center opening. The marginal power of the lens at this point can then be measured. Because of the prism power introduced by tipping of the lens with respect to the opening, an additional modification was introduced. This is a prism attachment which brings the emergent light beam into the field of view of the observing telescope. All three of the attachments are designed to fit any standard power-measuring instrument and will not prevent use of the instrument for measuring axial power.

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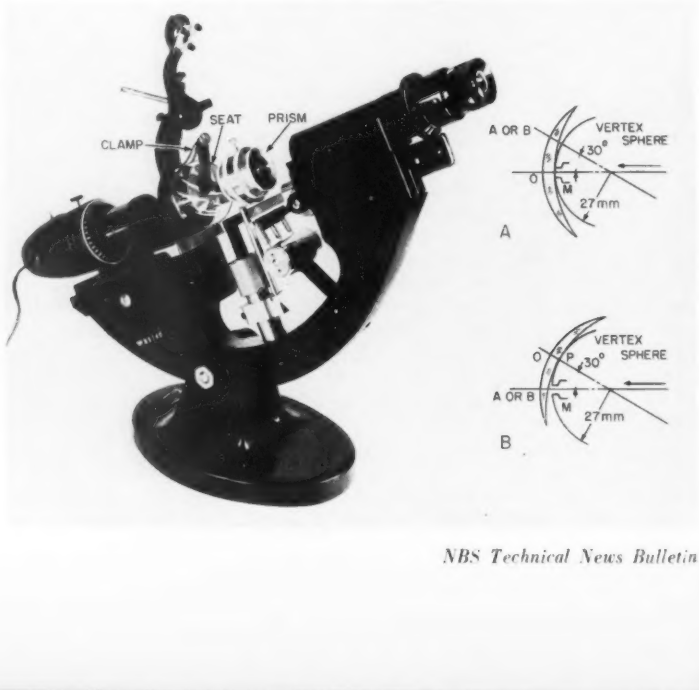
[1] *For further technical details, see* Instrument for measuring marginal power of spectacle lenses, *by Francis E. Washer, J. Opt. Soc. Am. (in press).*

[2] *For further technical details, see* A simplified method of measuring the marginal powers of spectacle lenses, *by Francis E. Washer, J. Research NBS* **55,** 79 (1955) *RP2607.*



Attachments for measuring lens marginal power in place on a standard vertex power measuring instrument with which optometrists test spectacle lenses. Optical center of lens under test is clamped against opening of a hemispherical seating device that can be attached to standard instrument (right A). Lens can be tipped to an angle of 30° (right B) so that its power can be measured at marginal points. Radius of seating surface is 27 mm, value customarily accepted as the axial distance between the back of a spectacle lens and eye's center of rotation. A prism attachment, to right of the clamping device, corrects for prism power introduced by tipping the lens under test.

The International Geophysical Year

NBS SCIENTISTS are playing an important role in the International Geophysical Year of 1957–1958. During the IGY, scientists from more than 40 nations will make simultaneous world-wide studies of the earth's interior, its crust, its oceans, its atmosphere, and its immediate cosmic environment. The results of this international enterprise will provide a greater understanding of earth physics. Also it will have direct application to the everyday affairs of human life in navigation, communication, instrumentation, and standards of measurement. The United States National Committee for the IGY, organized by the National Academy of Sciences—National Research Council, is planning and directing United States participation. The National Science Foundation is responsible for the Government's fiscal sponsorship of the program.

Since it is not economically feasible for scientists to make intensive observations every day during the Year, a series of "World Days" has been selected for more detailed observations. The Bureau has been chosen to select additional days when scientists will make their most frequent and most intensive observations from a global network of observatories and laboratories. In addition, other special days will be selected during the Year to watch certain upper atmosphere phenomena. As an extension of its regular radio warning service, the Bureau will predict magnetic and ionospheric storms high above the earth several days in advance. The Solar Noise Radio Patrols, some of which will be operated by NBS, will observe—with radio telescopes—the surface of the sun for unusual radio activity and will transmit their data to NBS. From these data storms can be predicted. Observers along the global network will be alerted so that they can prepare to study these phenomena and their effects upon weather and communications.

Many universities and Government agencies are cooperating in studies of the ionosphere—that electrically charged region of rarefied air, 65 to 300 miles above the earth's surface, which makes long-range radio communication possible. The Bureau has been investigating ionospheric radio propagation for many years, and part of this program will be enhanced for the Year. NBS will be the agency primarily responsible for vertical sounding—a radar-like scanning of the various layers of the ionosphere. In addition to the many ionospheric radio stations that the Bureau already maintains, it will design and procure equipment for 14 more such stations. Three of these will be operated by the U. S. Army, 4 by cooperating South American countries, and the remaining 7 by NBS including several on the Antarctic continent. The Bureau will be responsible for reviewing and publishing all the data received from these stations.

NBS scientists will also study ionospheric "forward scattering" in the vicinity of the equator. "Forward scattering" is a phenomenon recently discovered which has led to a new technique for long-range radio communication. The study will require installing and operating field equipment on the west coast of South America. The Bureau is now operating radio noise (static) recording stations, and others will be added for the IGY program. Another NBS activity will be to design recording photometers for aurora and airglow investigations. The Bureau will operate two of a chain of stations containing these instruments, and will reduce the data for the whole chain.

The Bureau is also preparing to play a major supporting role in the Earth satellite program. Indirect ionospheric measurements acquired from the Bureau's farflung network of ionospheric sounding stations will be coordinated with similar *in situ* measurements made from the satellite. Aurora and airglow will be observed by the satellite from above while the network of ground stations are making the same observations from below. The satellite may also be able to detect and measure the solar particles that have such a profound influence on magnetic and radio communication disturbances; NBS already plays an important part in interpreting the worldwide effects of this particle bombardment. NBS scientific stations throughout the world will aid in tracking the satellite. The selection of the World Days is expected to influence the timing of satellite launchings, since it is desirable that some satellite experiments be conducted during a period of high-solar activity and unusual terrestrial phenomena.

A number of the Bureau's senior staff members are providing full-time or part-time professional guidance and technical advice to the International Geophysical Year. Mr. Alan H. Shapley, physicist in the Bureau's Radio Propagation Physics Division, is Vice-Chairman of the U. S. National Committee and a member of the Executive Committee. Dr. Allen V. Astin, Director of the Bureau, and Dr. Lyman J. Briggs, NBS Director Emeritus, are members of the U. S. National Committee. Mr. Hugh Odishaw, formerly assistant to the Director of the Bureau, is Executive Secretary of the U. S. National Committee of the International Geophysical Year and the Executive Committee. Mr. Ross C. Peavey, on leave from NBS, is the U. S. N. C. Administrative Officer and recording secretary of the Ionosphere Panel. Dr. F. E. Roach is on the Technical Panel on Aurora and Airglow. Mr. Shapley is also Chairman of the Solar Activity and World Day Panels and a member of the Ionosphere Panel. On the Data Processing Committee are Mr. W. A. Wildhack as Chairman, Dr. Harold K. Skramstad and Mr. Joshua Stern as consultants, and Dr. Ralph J. Slutz. Dr. Slutz is also a member of the Technical Panel on the Ionosphere. Mr. A. G. McNish is a consultant to the Technical Panel on Geomagnetism, and Mr. A. Glen Jean is a consultant to the Ionosphere Panel.

Absolute Calibration of the National Photon

THE NATIONAL BUREAU OF STANDARDS has recently redetermined the emission rate of the Nation's primary standard photoneutron source. To do this, an absolute calibration method was developed that is more precise and more easily performed than most existing techniques. The work was conducted by a neutron calibration group led by J. A. De Juren. As a result of this study, the emission rate, or "Q", previously established for the standard was confirmed and the accuracy of the measurement increased.

Development of nuclear reactors has made possible widely increased neutron irradiation research. As a consequence, reliable standards are needed for accurately calibrating neutron thermal fluxes and measuring neutron yields. The Bureau is engaged in a program to provide such standards and to establish improved methods of neutron measurement. The present recalibration was initiated partially as a result of the wide discrepancies revealed by international comparisons of neutron standards.[1]

The NBS primary photoneutron standard is a radium-gamma-beryllium source that produces neutrons by the reaction of gamma rays with beryllium. The source consists of 1 curie of radium bromide in a platinum-iridium capsule that is placed in the center of a beryllium sphere, 4 cm in diameter. Since the capsule absorbs the alpha particles from radium and its decay products, only gamma rays can enter the beryllium sphere. A secondary photoneutron standard, similarly constructed and calibrated relative to the primary, is available to other laboratories for comparison measurements.

The neutron emission rate from the NBS standard is more nearly constant than that from a radium-alpha-beryllium source. Sources of the latter type, which are in more general use, produce neutrons by the reaction of alpha particles with beryllium. The emission rate for such a source increases with the growth of polonium—an alpha emitting decay product of radium. A photoneutron source, on the other hand, is not subject to this difficulty. Thus, its emission rate is more nearly constant over a long period of years. A decrease in emission rate does take place, but because

One of the methods used to compare neutron sources. Lead-wrapped graphite pile slows down neutrons emitted by a source in the pile. Thermal-neutron density is then measured by counting neutrons with a boron-lined counter or by activating and beta-counting indium foils. A foil is being placed in a cut in one of the graphite rods. *Upper left:* The National Photoneutron Standard.

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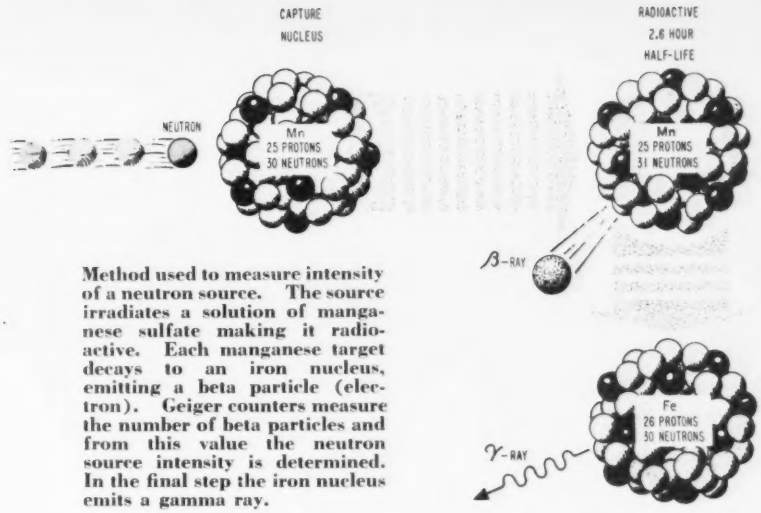


Method used to measure intensity of a neutron source. The source irradiates a solution of manganese sulfate making it radioactive. Each manganese target decays to an iron nucleus, emitting a beta particle (electron). Geiger counters measure the number of beta particles and from this value the neutron source intensity is determined. In the final step the iron nucleus emits a gamma ray.

the decrease follows the decay law of radium, it can be corrected for simply.

With this primary standard, other neutron sources are calibrated for Government, educational, and industrial laboratories. These sources of known strength are useful for convenient routine checking of radiation-monitoring instruments. They are also necessary for certain cross-section measurements which predict the occurrence of particular nuclear reactions in a definite energy range.

An absolute calibration of a neutron source is the determination of its emission rate by fundamental measurements. In such a calibration the fast neutrons emitted by the source are usually thermalized, or slowed down, by directing them into a moderating medium. The thermal-neutron capture rate in the medium is then measured. As the neutron-capture rate is equal to the emission rate, the Q of the source is determined.

Both the NBS standard neutron source [2] and thermal neutron density [3] have already been calibrated by methods in which the key measurement is the absolute counting rate of alpha particles from thin boron films. In the present calibration,[4] the key measurement is the 4π counting of the absolute activity of a very thin layer of manganese sulfate.

Two previous absolute calibrations of neutron sources have been made at other laboratories in which manganese sulfate solutions were employed to moderate and absorb the emitted neutrons.[5] Both methods require determination of the absolute beta-ray activity of a fairly thick layer of powder. Their precision is about 8 percent. The accuracy obtained with the present relatively simple technique is of the order of 2 percent.

Basically, the NBS method involves the irradiation by the standard source of a large bath of manganese sulfate and the subsequent measurement of the resulting manganese activity by a calibrated dip counter. The source is placed in the center of a bath whose volume is large enough to make neutron leakage negligible. The neutrons are slowed down by collisions with hydrogen nuclei and are nearly all captured at thermal energies. From a knowledge of the neutron capture cross sections, and the manganese sulfate concentration, the fraction (0.35) of neutrons

Manganese sulfate bath used as the moderator. A dip-counter apparatus (center) determines the radioactivity of the solution after irradiation by the source. *Inset:* NBS 4π counter used to make absolute measurements of primary neutron standard's radioactivity.

captured by the manganese is computed. Using this fraction, and the measured activity, the emission rate of the source is determined.

The dip counter is calibrated in the following manner: Approximately 1 liter of the inactive manganese sulfate solution from the bath is irradiated in an intense neutron flux. The absolute activity of a small amount of this solution is then determined by 4π counting. Concurrently, 1 liter of the activated solution is returned to the inactive solution in the large bath, the solution is stirred, and the resulting activity is measured with the dip counter. The number of radioactive manganese nuclei in the liter is obtained from the 4π determination. Thus the dip counter is calibrated by a known manganese activity.

From the present measurements, a value of $1.25_0 \times 10^6$ ($\pm 2\%$ standard error) neutrons per second was determined for the NBS standard photoneutron source (1954). When combined with the previous independently measured value (see footnote 2) of $1.26_5 \times 10^6$ ($\pm 3\%$ standard error) neutrons per second, an improved value of $1.25_5 \pm 0.021 \times 10^6$ neutrons per second is obtained for the emission rate of the standard.

[1] Pile neutron research, *by D. J. Hughes, p. 79 (Addison-Wesley, 1953).*

[2] Absolute calibration of the NBS photoneutron standard: I, *by J. A. De Juren, D. W. Padgett, and L. F. Curtiss, J. Research NBS* **55,** *63 (August 1955) RP2605.*

[3] Absolute calibration of the NBS standard thermal neutron density, *by J. A. De Juren, and H. Rosenwasser, J. Research NBS* **52,** *93 (February 1954) RP2477.*

[4] Absolute calibration of the NBS standard neutron source II absorption in manganese sulfate, *by J. A. De Juren and J. Chin, J. Research NBS (in preparation).*

[5] *R.. D. O'Neal and G. Sharff Goldhaber, Phys. Rev.* **69,** *368 (1946); F. Alder and P. Huber, Helv. Phys. Acta* **22,** *368 (1949).*

Radiant Panel Test for Flame Spread

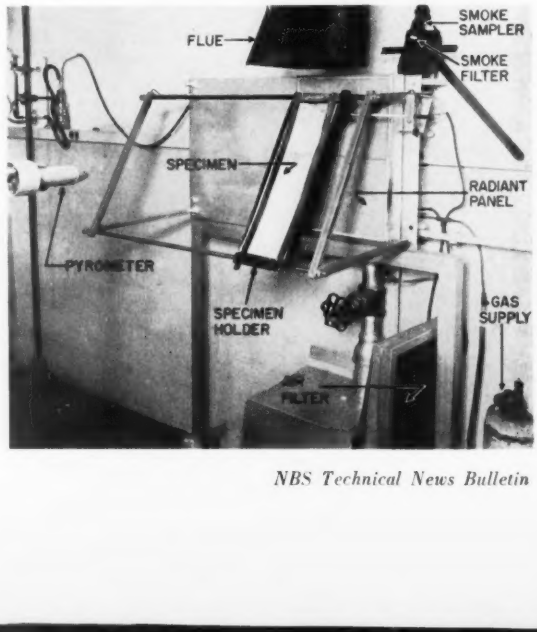
Determines Flammability of Building Materials

A METHOD for measuring the rate at which flames spread along the surfaces of various materials has been developed by the Bureau's fire protection laboratory. This convenient and reproducible method for rating building materials—especially those used for internal finishing—will provide both manufacturers and builders with design data to be used for reducing fire hazards in buildings. Developed by Daniel Gross, J. J. Loftus, and A. F. Robertson, the method is simple and versatile, the equipment compact and relatively inexpensive. Both the equipment and the method can be duplicated quite easily by manufacturers for quality control testing and by laboratories for evaluating flammability of materials.

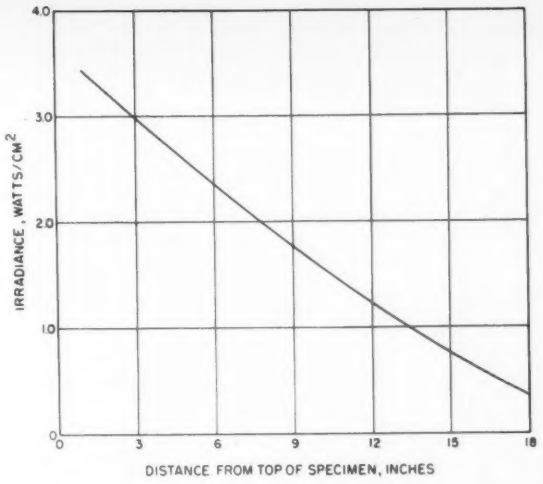
By permitting visual measurement of the rapidity and severity of flame propagation, the test assesses quantitatively the variables that contribute to the spreading of fire along the surface of building materials. Results from the test appear to be somewhat similar to those obtained in tunnel tests with much larger and more cumbersome apparatus.

Standard test procedures have been in use for many years for evaluating the fire resistance or fire endurance of many types of building structures. In these tests a member's ability to act as a fire barrier when exposed to a "standard" fire is measured by the interval of time required for structural collapse, fire break-through, or excessive heat transmission. Methods for evaluating the rate at which a fire will develop or spread through a room or portion of a building are not so well standardized. The Bureau has studied a variety of test methods that have been used for this purpose. When used to evaluate the flame spread properties of many materials the method described here is considered to be an improvement over others previously used or proposed.

The apparatus consists of a radiant panel, a frame for supporting the test specimen and associated measuring equipment. The radiant panel, a 12- by 18-in. section of porous refractory, is enclosed by a cast-iron frame. The panel is mounted in a vertical plane and a homogeneous gas-air mixture supplied from the rear is burned in contact with the refractory panel. About one-half hour after ignition the panel approaches an equilibrium temperature and radiates energy at the



Apparatus set up for flame spread test. Smoke sampler is inserted into the open top of smoke flue just before starting test. Air filter at bottom right keeps dust from clogging porous radiant panel.



Energy flux along center line of specimens mounted on rack of flame spread apparatus.

same rate as a blackbody at 700° C (1,292° F). Energy output is measured by a radiation pyrometer sighted on the 10-in. diameter circular central area of the panel, and can be maintained constant by regulating the gas-flow rate. The heat content of the gas supplied is 1,360 Btu/min. calculated on the basis of the measured gas-flow rate and the total heating value of the gas.

The test specimen, measuring 6 by 18 in., is placed in a formed sheet-metal holder and is backed with a sheet of asbestos board. Ruled markings placed at 3-in. intervals along the test specimen's length and corresponding marks on the specimen holder aid in making observations of the flame front position. The loaded specimen holder is placed on a supporting frame inclined 30 degrees to the vertical panel surface. Timing is started when the holder and specimen are in position. The progress of the flame front, occurrences of flashing, buckling, and blistering are observed and recorded. A pilot igniter fed by an acetylene-air mixture serves both to start flaming at the upper edge of the test specimen and to ignite combustible gases rising from it. The flame front, which for homogeneous materials is practically uniform across its width, progresses downward and is unobscured by the rising flames and smoke. The intensity of radiation at the specimen's surface is essentially uniform across the width but varies along its length. An electrical timer is used to measure the progress of flaming along this length. The test duration is 15 min or until sustained flaming traverses the entire 18-in. specimen length, whichever time is less.

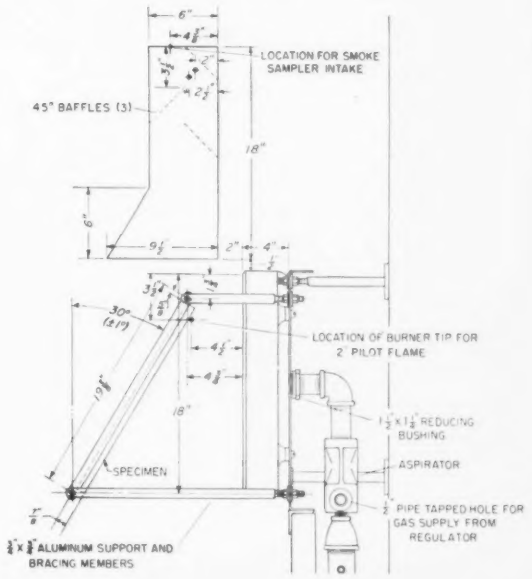
A small metal stack is placed under a hood above the test specimen to receive the hot products of combustion and smoke. Thermocouples placed within the stack carrying the exhaust gases measure temperatures and are automatically written on a potentiometer recorder. These thermocouples are calibrated for standardization of test results by means of a diffusion flame from a multiported burner. With the radiant panel in operation this burner (ten No. 50 drill holes spaced $\frac{5}{8}$ in. on centers in $\frac{1}{4}$-in. standard pipe) is placed in a horizontal position 1 in. below the upper edge of an asbestos cement specimen supported in the test frame. Observations are then made of the stack thermocouple temperature rise as a function of the rate of heat supply to the burner. A sampling tube is also placed within the stack to collect a smoke deposit on a glass fiber filter paper. An aspirator is used during the test to draw the stack gases through the paper at a constant rate. The weight of the resultant deposit as determined after the test's completion is a direct, quantitative measure of smoke evolution during flaming.

Specimens for test are brought to equilibrium in an ambient temperature of 75° F and 50 percent relative humidity. Each specimen, of which there are usually several duplicates, is removed individually from the conditioning room and tested immediately after transfer to the testroom.

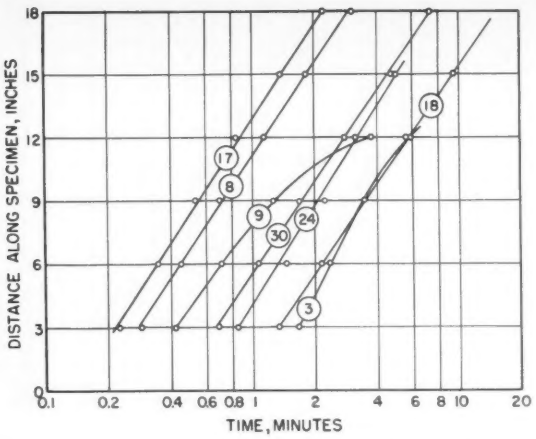
Results and Calculations

The flame spread index, I_s, of materials is defined as the product of the flame spread factor, F_s, and the heat evolution factor Q. Thus:

$$I_s = F_s Q$$



Critical dimensions and positions of specimen rack, radiant panel, and stack. Sheet-steel stack is 9 in. wide; radiant panel is 13 in. wide; and has a 12 by 18 in. radiating surface.



Flame-front progression along surfaces of various specimens. Numbers of the curve refer to numbered specimens described in table 1.

where,

$$F_s=\left(1+\frac{1}{t_3}+\frac{1}{t_6-t_3}+\frac{1}{t_9-t_6}+\frac{1}{t_{12}-t_9}+\frac{1}{t_{15}-t_{12}}\right)$$

where, $t_3 \ldots t_{15}$ corresponds to the time in minutes from initial specimen exposure until arrival of the flame front at positions of 3, 6, 9, 12, and 15 in. along the length of the specimen.

$$Q=0.1\ \Delta\Theta/\beta$$

where, $\Delta\Theta$ is the observed maximum stack thermocouple temperature difference in deg F above that for an asbestos cement board specimen and β, the calibration constant, determined by the slope of the calibration curve for the stack thermocouple temperature versus heat input rate in units of °F min/Btu.

With these formulas, calculations based on test data are used to classify various materials. Based on measurements of a number of selected materials this classification shows an ordering somewhat similar to that obtained on 20-in. by 25-ft specimens with the tunnel test method as used at Underwriter's Laboratories. The numerical constant in the heat evolution factor term (Q) has been arbitrarily selected to provide a flame spread index of approximately 100 for red oak.

TABLE 1. *Flame spread test results*

Specimen No.	Material	Nominal thickness	Bulk density	Moisture	Flame spread index [a]	Smoke
		in.	*lb/ft³*	*%* [b]		*mg*
17	Fbd.[c] perf.[d] tile, finish removed	1/2	15.7	5.4	336	0.1
28	Fbd. "A"	1/2	20.0	8.0	278	.4
8	Fbd. "J" unfinished	1/2	18.0	7.0	241	.2
30	Plywood, unfinished exterior	1/4	42.3	6.8	143	.3
18	Hardboard common "H"	7/32	59.8	3.8	136	4.1
23	Hardboard common "M"	1/4	63.5	3.8	121	5.2
16	Fbd. perf. tile	1/2	16.7	5.8	116	0.2
13	Fbd. "J" and paint "A"	1/2	18.3	6.5	107	.4
24	Red oak	3/4	40.0	6.5	99	.3
21	Fbd. "C"	1/2	19.7	6.0	94	.2
9	Fbd. factory finish	1/2	20.2	6.6	83	.2
12	Fbd. "J" and paint "B" 250 ft²/gal	1/2	17.0	6.2	59	.6
11	Fbd. "J" and paint "B" 125 ft²/gal	1/2	17.8	6.9	27	.9
26	Gypsum board "G"	3/8	50.5	.....	14.3	.0
3	Gypsum board "K"	3/8	47.4	.....	13.3	.1
6	Mineral base tile	3/4	19.3	3.4	10.5	.0
22	Fbd. "I" retardant finish	1/2	19.0	6.4	4.5	.5
14	Fbd. "J" mineral spray	1/2	21.9	7.7	3.4	.2
7	Glass fiber batt	1	4.3	1.2	1.8	.2
2	Cellulose-mineral board	7/8	47.8	7.5	1.3	.1
5	Glass fiber tile	3/8	10.3	0.6	1.2	.3
15	Fbd. "J" 1/8 in. mineral surface	5/8	42.2	7.5	1.2	.2
31	Plywood exterior aluminum foil finish	1/4	41.6	6.3	0.9	.1
4	Glass fbd.	2	11.0	0.4	.6	.2
1	Asbestos cement board	3/16	117.0	.6	0	.0

[a] Each tabulated value is the arithmetical mean of five specimen tests.
[b] Based on weight after drying at 221° F.
[c] Fiberboard.
[d] Perforated.

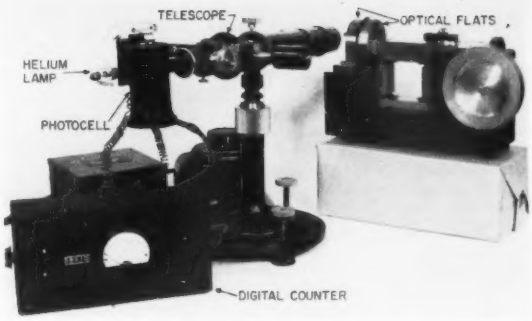
Table 1 lists flame spread index data together with smoke measurements, which have been made on a large variety of building materials. The order in which these materials are classified by the test method appears to be similar to the flame spread hazard as adjudged from previous experience. Experiments to correlate the test results with the actual hazard are being planned.

Further technical details may be obtained from the Fire Protection Section, National Bureau of Standards, Washington 25, D. C.

Photoelectric Counter for Interference Fringes

A PHOTOELECTRIC DEVICE that accurately counts linear interference fringes has been developed by the engineering mechanics laboratory. Requiring no modification of standard fringe-viewing equipment, this compact, inexpensive apparatus counts up to 200 fringes per minute. Application of the counter has expedited strain-gage calibrations without loss of accuracy. It also has permitted using interferometry with strain gages over greater ranges of extension than is practical with visual counting. The instrument [1] was developed by H. R. Smith and D. R. Tate under a program of basic instrumentation sponsored at the Bureau by the Department of Defense and the Atomic Energy Commission.

Precisely calibrating certain types of strain gages requires an interferometer. This instrument measures



Automatic photoelectric apparatus developed for rapid, accurate counting of interference fringes. In operation, interference fringes are produced by two optical flats using light from a helium lamp. As each fringe moves past telescope, photocell converts light variations produced by the fringes into electrical-current variations. Cyclic changes in current activate a solenoid-operated digital counter. In this fashion, fringes can be counted at rates up to 200 per minute.

distances in terms of the interference fringes between wave trains of monochromatic light. Normally an operator must visually count as many as several thousand fringes when making a calibration. In doing this, he may suffer fatigue and eye strain, thus limiting him to a slow counting rate with frequent rest periods. The photoelectric counter eliminates these difficulties with a system that counts fringes automatically.

The instrument's principal components are a 931–A photomultiplier tube, a two-stage d-c amplifier, a plate current meter and relay, and an electrical impulse counter. A helium discharge tube is used as a light source. It is activated by a step-up transformer that, in turn, is operated by a variable-voltage transformer. Light from the tube is filtered to isolate the 5876-angstrom line of helium. The impulse counter operates from this line.

The Bureau's apparatus is attached to the eyepiece tube of a viewing system. A variable telescope is provided to observe the interference fringes. Several apertures are placed in the optical system to control the light entering a variable slit in the telescope eyepiece.

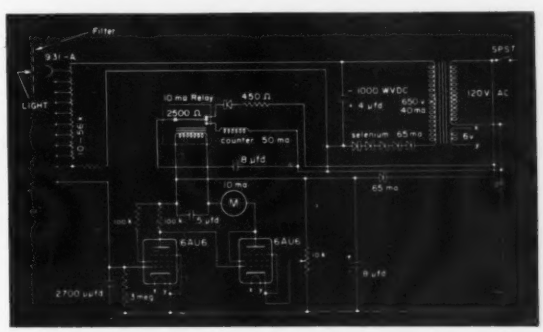
In operation, a linear interference pattern is produced by two optical flats mounted on a special frame. One flat is stationary, the other is movable. The stationary flat is mounted on a heavy base which also holds a worm gear-driven micrometer screw. The movable flat is mounted on a table which is positioned by the micrometer screw. Adjustment of the movable flat with respect to the stationary one is accomplished by varying three screws set in the frame of the moving table. With these adjustments, a condition is obtained in which a single fringe covers the area exposed by the telescope's variable slit. When this is accomplished the eyepiece is replaced by the photomultiplier equipment and, with light intensity adjusted, the device is ready for use.

As each bright band moves across the slit opening, the total light reaching the photoelectric cell changes from a minimum to a maximum and back again. The photocell and amplifier convert the light variations to electrical-current variations, which are indicated on a milliammeter. When the current is sufficiently great, it closes a relay that controls a solenoid-operated digital counter. The counter registers once when activated by a capacitor discharged by the closing relay. While the relay is closed, the capacitor is removed from the charging current. When the relay is open, the capacitor is again charged. The relay closes at a comparatively high value of current and will not open until a low value is reached. This feature allows a fringe to move back and forth by a small amount without being counted more than once.

The 931–A photomultiplier used is a nine-stage tube that operates with a maximum of 125 volts per dynode. A potential of 90 volts per dynode gives a sufficiently large output signal between 1.5 and 2.5 volts dc. The signal is introduced to the grid of the voltage amplifying pentode with a bypass for 120 cycles. This amplified output then drives the second and final tube for current amplification. Manual current control is provided by connecting the cathode of the second tube to the center tap of a potentiometer.

In using the instrument it is desirable to count an integral number of fringes. To make such a count, it is necessary to stop the last fringe in the same relative position as the initial one. This is done by selecting some reproducible point on the current fluctuation cycle as indicated by the milliammeter. In the application of the counter to the NBS calibration of strain gages, the minimum current indication has been used. Such a value has been found to be reproducible with errors not exceeding one-twentieth of a fringe.

[1] *Similar instruments of relatively complicated design have been described previously by Bureau staff members. For background technical details see,* A photoelectric recording interferometer for measurement of dimensional changes, *by R. N. Work, J. Research NBS* **47,** *80 (1951);* Photoelectric interferometer for high polymer research, *NBS Tech. News Bull.* **35,** *150 (Oct. 1951);* Electronic fringe interpolator for an optical interferometer, *by R. D. Huntoon, A. Weiss, and J. W. Smith, J. Opt. Soc. Am.* **44,** *264 (1954).*



Wiring diagram of interference fringe counter developed for use in strain-gage calibrations.

Analysis of Jet-Engine Alloys

The Bureau uses ion-exchange columns to separate metallic constituents in the analysis of jet-engine alloys. Metallic ions are adsorbed on the powdered resins within the columns, and individual components are removed in fractions by washing with a series of solvents. The NBS procedure permits the quantitative determination of nickel, manganese, cobalt, and iron in the presence of niobium, molybdenum, tantalum, tungsten, silicon, and copper.

IN RECENT YEARS development of complex high-temperature alloys for jet engines has revealed a lack of accurate methods for chemical analysis of such materials. To obtain the desired combination of high heat resistance and low-thermal expansion, the composition of these alloys must be carefully controlled during manufacture. Rapid spectrographic procedures can supply this control provided materials that have been carefully analyzed by other means are available for comparison. However, the high-temperature alloys contain some of the less well-known elements—molybdenum, titanium, tungsten, and niobium—whose chemical properties make analytical separation difficult. In such mixtures, even the determination of nickel—ordinarily a simple matter—may become involved.

Seeking a new approach to this problem, the Bureau has developed an accurate procedure [1] for analyzing cobalt-base jet-engine alloys through use of ion-exchange techniques, that is, the differential retention of metal ions on the surfaces of certain resins. The procedure permits quantitative determination of nickel, manganese, cobalt, and iron in the presence of niobium, molybdenum, tantalum, tungsten, silicon, and copper. Development was carried out by J. L. Hague, E. E. Maczkowske, and H. A. Bright of the Bureau's Analytical Chemistry Section.

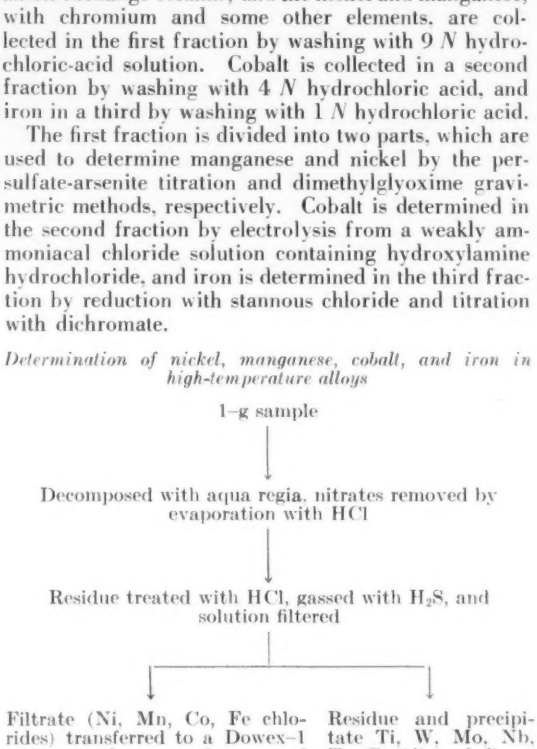
The procedure was designed particularly for the analysis of an S–816 type of alloy containing 40 percent of cobalt, 20 percent of nickel, 20 percent of chromium, and 4 percent each of niobium, tungsten, and molybdenum. The remainder of the alloy is largely iron, manganese, carbon, and silicon.

In the analysis the first step is to dissolve the alloy in aqua regia. The niobium, tantalum, tungsten, and silicon are then rendered insoluble by hydrochloric-acid dehydration. The solution is treated with hydrogen sulfide to precipitate molybdenum and copper, and filtered. Repeated evaporation of the filtrate with hydrochloric acid and hydrogen peroxide provides a chloride solution of the elements in the proper valence for the ion-exchange fractionation.

The solution of metal chlorides is transferred to an anion-exchange column; and the nickel and manganese, with chromium and some other elements, are collected in the first fraction by washing with 9 *N* hydrochloric-acid solution. Cobalt is collected in a second fraction by washing with 4 *N* hydrochloric acid, and iron in a third by washing with 1 *N* hydrochloric acid.

The first fraction is divided into two parts, which are used to determine manganese and nickel by the persulfate-arsenite titration and dimethylglyoxime gravimetric methods, respectively. Cobalt is determined in the second fraction by electrolysis from a weakly ammoniacal chloride solution containing hydroxylamine hydrochloride, and iron is determined in the third fraction by reduction with stannous chloride and titration with dichromate.

Determination of nickel, manganese, cobalt, and iron in high-temperature alloys


1–g sample
Decomposed with aqua regia, nitrates removed by evaporation with HCl
Residue treated with HCl, gassed with H_2S, and solution filtered
Filtrate (Ni, Mn, Co, Fe chlorides) transferred to a Dowex–1 anion exchange column and washed successively with about 400 ml of diluted HCl
Residue and precipitate Ti, W, Mo, Nb, Ta, Cu (discarded)
(9 N wash) 1st fraction (Ni, Mn): Nickel determined as nickel dimethylgloxime; Mn, by persulfate-arsenite method
(4 N wash) 2d fraction (Co): Cobalt electrolyzed in ammoniacal chloride solution
(1 N wash) 3d fraction (Fe): Iron determined by $SnCl_2$-$K_2Cr_2O_7$ method

[1] *For further details, see* Determination of nickel, manganese, cobalt, and iron in high-temperature alloys, using anion-exchange separations, *by John L. Hague, Edwin E. Maczkowske, and Harry A. Bright, J. Research, NBS* **53,** *353 (1954) RP2552.*

Thirteenth Session of the International Commission on Illumination

SEVERAL important recommendations relating to international standardization tentatively were adopted at the Thirteenth Session of the International Commission on Illumination (CIE), held in Zürich, Switzerland, June 13 to 22, 1955. Over 400 delegates from 27 countries attended the Session. The United States was represented by 37 delegates, among whom were L. E. Barbrow, F. C. Breckenridge, D. B. Judd, and R. P. Teele of the National Bureau of Standards. Mr. Barbrow served as Secretary of the U. S. Delegation and as a member of the Executive Committee of the Commission.

Before confirmation the recommendations of the Zürich Session will receive final consideration at the Annual Meeting of the U. S. National Committee of the Commission, which will be held on October 27 and 28. The three most important recommendations will result in:

(1) Publication in 1956 of an International Lighting Vocabulary defining terms in English, French, and German and listing synonymous terms in other languages.

(2) Furtherance of studies of color-mixture functions using a 10-degree field, and the ultimate adoption of color-mixture functions based on procedures which in every case yield a complete match of the two fields being compared.

(3) Adoption of 3-, 4-, 5-, and 6-color signal systems with definitions of all of the colors.

The second recommendation, regarding color-mixture functions, was made as the result of a report on colorimetry presented by Dr. Judd. Adoption of new color-mixture functions in the future will have far-reaching implications, not only in colorimetry but also in photometry. The present functions, which were based on data obtained with a 2-degree field, have been used internationally since 1931. The 1931 $\bar{y}_\lambda$ function, which is identical with the relative photopic luminous efficiency curve adopted by the CIE in 1924 and used internationally for photometry of sources differing in spectral characteristics, will probably be changed for colorimetric purposes. This will leave for decision the question as to whether the curve adopted for photometry should be identical with that adopted for colorimetry. If it is, the photometric values assigned to fluorescent and gaseous-discharge lamps will probably have to be changed materially.

On the basis of an analysis of the signal-light problem in a secretariat report presented by Mr. Breckenridge, the Commission adopted a recommendation on the use of 3-, 4-, 5-, and 6-color signal systems for all forms of transportation signaling. Mr. Teele presented data on the shape of the short-wavelength end of an improved relative photopic luminous efficiency curve. The U. S. National Committee will receive comments regarding the tentatively adopted recommendations for consideration at its October meeting. Comments should be sent to Mr. L. E. Barbrow, National Bureau of Standards, Washington 25, D. C.

Publications of the National Bureau of Standards

Journal of Research of the National Bureau of Standards, volume **55,** No. 3, September 1955 (RP2610 to RP2616 incl.). Annual subscription $4.00.

Technical News Bulletin, volume **39,** No. 9, September 1955. 10 cents. Annual subscription $1.00.

CRPL–133. Basic Radio Propagation Predictions for December 1955. Three months in advance. Issued September 1955. 10 cents. Annual subscription $1.00.

Research Papers

Journal of Research, volume ***55,*** *No. 3, September 1955. Single copies of the Journal vary in price. Single copies of Research Papers appearing in the Journal are not available for sale. The Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., will reprint 100 or more copies of a Research Paper. Request for the purchase price should be mailed promptly to that Office.*

RP2610. Heat capacity of some butadiene-styrene copolymers from 0° to 330° K. George T. Furukawa, Robert E. McCoskey, and Martin L. Reilly.

RP2611. Setting reaction of zinc oxide and eugenol. Henry I. Copeland, Jr., Gerhard M. Brauer, W. T. Sweeney, and A. F. Forziati.

RP2612. Development of a photoresist for etching designs in glass. Chester I. Pope and Raymond Davis.

RP2613. Preferred orientation in stark rubber. C. J. Newton, L. Mandelkern, and D. E. Roberts.

RP2614. Thermodynamic properties of some gaseous halogen compounds. William H. Evans, Thomas R. Munson, and Donald D. Wagman.

RP2615. Atomic negative-ion-photodetachment cross-section and affinity measurements. Stephen J. Smith and Lewis M. Branscomb.

RP2616. A study of the final stages of the austenite to martensite transformation in SAE 1050 steel. Melvin R. Meyerson and Samuel J. Rosenberg.

Circulars

C563. Periodicals and serials received in the library of the National Bureau of Standards, April 1955. Natalie J. Hopper and Dorothy H. Pepperman. 20 cents.

Handbooks

H44. 2d Edition. Specifications, tolerances, and regulations for commercial weighing and measuring devices. $2.00.

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Contents

	Page
Sixth National Conference on Standards	133
NBS-BuAer preferred circuits program	134
Spectacle tester	137
The International Geophysical Year	139
Absolute calibration of the national photoneutron standard	140
Radiant panel test for flame spread	142
Photoelectric counters for interference fringes	144
Analysis of jet-engine alloys	146
Thirteenth Session of the International Commission on Illumination	147
Publications of the National Bureau of Standards	147

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X-ray diffraction studies of tooth structure. Aaron S. Posner. Norelco Reporter (750 South Fulton Ave., Mt. Vernon, N. Y.) **2,** No. 2, 26 (March–April 1955).

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Determination of aldehyde in cellulose—A review of methods. William K. Wilson. Tappi (122 East 42d St., New York 17, N. Y.) **38,** No. 5, 274 (May 1955).

Gas tube stabilized power supplies. Sherwin Rubin and Douglas Scott. Tele-Tech (480 Lexington Ave., New York 17, N. Y.) **15,** No. 7 (July 1955).

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Patents

(The following U. S. Patents have been granted to NBS inventors).

2,706,244. April 12, 1955. Pulse transpondor. Milton L. Kuder. Licensed to the United States of America as represented by the Secretary of the Navy.

2,706,287. April 12, 1955. Telemetering in-flight calibrator. Myron G. Pawley, Leland L. Parker, and Walter A. Hereth. Assigned to the United States of America as represented by the Secretary of the Navy.

2,707,811. May 10, 1955. Rheostat for aircraft panel light control. Theodore H. Projector. Licensed to the United States of America as represented by the Secretary of the Navy.

2,708,244. May 10, 1955. Piezoelectric transducers using lead titanate and lead zirconate. Bernard Jaffe. Assigned to the United States of America as represented by the Secretary of the Army.

2,708,387. May 17, 1955. Rapid spectroscopic determination of total water content. Herbert P. Broida and Harold J. Morowitz. Licensed to the United States of America as represented by the Secretary of Commerce.

2,710,578. June 14, 1955. Arming device. Jacob Rabinow. Assigned to the United States of America as represented by the Secretary of the Navy.

2,711,593. June 28, 1955. Airfield lighting simulator. Amos L. Lewis (Navy) and Francis C. Breckenridge. Licensed to the United States of America as represented by the Secretary of the Navy.

2,712,065. June 28, 1955. Gate circuitry for electronic computers. Robert D. Elbourn and Ralph J. Slutz. Assigned to the United States of America as represented by the Secretary of Commerce.

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